GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: February 23, 1979

Project Title: A Fusion Studies Program

Green card

Project No: E-26-644 (NOTE: Continuation of E-26-630)

Project Director: Dr. Weston M. Stacey, Jr.

Sponsor: U. S. Department of Energy; Oak Ridge Operations; Oak Ridge, TN 37830

Agreement Period: From 11/1/78 Until 10/31/79

Type Agreement: Contract No. DE-AS05-78ET52025, Modification No. 1 (formerly Contract No. ET-78-S-05-5683)

Amount: $70,000

Reports Required: Quarterly Technical Progress Reports; Final Report; Publication Preprints; Publication Reprints

Sponsor Contact Person (s):

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Defense Priority Rating: None

Assigned to: Nuclear Engineering (School/Laboratory)

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CA-3 (3/76)

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GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT TERMINATION

Date: 10/8/80

Project Title: A Fusion Studies Program

Project No: E-26-644 (NOTE: Continuation of E-26-630, Continued by E-26-656)

Project Director: Dr. Weston M. Stacey, Jr.

Sponsor: U.S. Dept. of Energy; Oak Ridge Operations; Oak Ridge, TN 37830

Effective Termination Date: 10/31/79

Clearance of Accounting Charges: —

Grant/Contract Closeout Actions Remaining:

None

_ Final Invoice and Closing Documents
_ Final Fiscal Report
_ Final Report of Inventions
_ Govt. Property Inventory & Related Certificate
_ Classified Material Certificate
_ Other ______________

NOTE: Continued by E-26-656

Assigned to: Nuclear Engineering (School/~~Laboratory~~)

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Project Code (GTRI)
Other ______________

CA-4 (1/79)

Georgia Tech Fusion Studies Project

Quarterly Progress Report, April 15, 1979

A. PLASMA WALL INTERACTION AND IMPURITY CONTROL

1. Impurity Control by Momentum Injection

A report (GTFR-7) has been published on the formalism that was developed for studying the effect of neutral beam injection on impurity transport. Work has been initiated to include temperature gradient effects in the formalism, in order to be able to realistically treat a reactor plasma.

2. Divertor-Gas Blanket

A report which describes the divertor/gas blanket model and presents the results of the study on the performance of the divertor and gas blanket has been completed and issued as GTFR-8 report. The study determined the divertor/gas blanket parameters that are required to efficiently shield the plasma.

The study on the static neutral gas blanket has shown that the thickness of the gas blanket required to handle reactor heat fluxes is large. The paper discussing the performance of the gas blanket has been accepted at the ANS meeting (Summer 1979). The neutral gas blanket model is being extended to represent a flowing gas blanket.

The divertor sheath potential effect on the heat and particle fluxes in the divertor has been included into the model and coded. Some test problems have been done to study the sheath effect on the divertor performance.

3. Neutral Particle and Impurity Transport

Impurity transport has been investigated for an axisymmetric plasma of arbitrary cross section and beta. Moments have been included up to the conservation of heat flux, as well as heat and particle sources, momentum inputs, and frictional effects. A two species (ion-impurity) calculation was carried out. Methods for treating the truncation term (heat fraction) are being studied in order to make useful estimates from the two species problem, and to lend insight into the direction of further studies on this topic.

A well defined test neutral transport problem has been received from Argonne using both their neutral transport calculation and the ANISN code. Comparisons of those results are being made with our neutral code in order to analyse the error introduced by the approximation and to provide a basis for its utilization in future calculations.

4. Divertor-Sheath Model

An alternate approach to the divertor sheath problem has been proposed and developed in concert with the ORNL Plasma Engineering Group and G. A. Emmert of the University of Wisconsin. In this formulation a plasma having bilaterial symmetry and containing a volumetric source of ions is modeled and the solution to the plasma potential determined numerically. The resulting protential profile includes sheath, presheath, and plasma potential effects whereas previous solutions only give the potential drop across the sheath region. This problem is currently being modified to include secondary electron emission, an extremely important effect in divertor collectors.

B. BURN PHASE CONTROL

1. Burn Dynamics Code Revision

Much of the past six months has been spent working on the dynamics code acquired from ANL. This work did not involve any major revision in the previously developed model. The primary purpose of the effort was: 1) to document the code, 2) to simplify the input and output formats, and 3) to simplify the program structure so as to make use and review of the code easier.

The input and output format changes encompass several features. The input is now structured so that only five major data blocks are needed. With this simple structure it is necessary to compile the program only once. The machine characteristics, formally contained in the code itself, are then submitted in a data file, which, when submitted with the compiled binary program, constitutes the problem package. This simplified format reduces the compilation and calculational time needed and allows a much greater freedom for examining various "burn-machine" senarios. The output format changes have been slightly altered. These changes, however, greatly aid in the ability to reproduce a scenario. The output lists all of the pertinent parameters in each scenario.

2. Field Ripple Control

The report on the ripple control calculations (GTFR-9) has been completed. The work now under way includes efforts to extend the control to longer burn times and to investigate the possibility of ripple control in alternative machines, in particular the INTOR device.

Annual Report

November 1, 1979 - October 31, 1980

A FUSION STUDIES PROGRAM

Prepared for the U.S. Department of Energy
under Contract No. DE-AS05-78ET52025

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A FUSION STUDIES PROGRAM

I. INTRODUCTION

Activities in three different areas of tokamak plasma systems analysis were carried out within the Georgia Tech Fusion Studies Program during the period November 1, 1979 through October 31, 1980. These areas are bundle divertor studies, burn control studies and flow reversal studies.

II. BUNDLE DIVERTOR STUDIES

The magnetic and engineering design considerations of a bundle divertor configuration in a tokamak reactor were studied. Codes required to carry out trade-off analyses were implemented. Several divertor configurations were analyzed in an attempt to find an acceptable configuration. At the present time, a configuration which is acceptable from both the field ripple and radiation shielding viewpoints has not yet been found, but progress is being made in this respect. The results of this work will be published in a Georgia Tech Fusion Report (GTFR) in the Fall of 1980, and the work will be continued.

Effects of bundle divertor magnetic field and helical magnetic island structure on self-consistent MHD plasma equilibria were analyzed. Preliminary results indicate that the magnetic islands and ergodic regions produced by the local field perturbations of a bundle divertor can alter the current profile and saturated tearing modes (observed as Mirnov oscillations) in tokamak plasmas. Several computer codes have been developed in the course of this work. Results of this work to date are documented in GTFR-15 and GTFR-16, and the work will continue.

III. BURN CONTROL

The formalism for ion heat conduction due to toroidal field ripple via ripple trapping, banana drift and ripple-plateau effects has been put on a basis that is consistent and computationally tractable. A computer code package incorporating this formalism and a proper averaging over poloidal flux surfaces is being developed. This code and a GTFR report documenting it will be completed in the Fall of 1980.

IV. FLOW REVERSAL

Although not supported by this contract, relevant work on the extension of the Stacey-Sigmar theory (Nuclear Fusion 19, 1665 (1979)) for impurity flow reversal by neutral beam injection to include temperature gradient and heat flux effects was also carried out at Georgia Tech. The extended theory will be published in the Fall of 1980 as a M.S. thesis and in a GTFR report, and the work will be continued under this contract.